FIRE MANAGEMENT NOTES

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U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

FIRE MANAGEMENT NOTES

An international quarterly periodical devoted to forest fire management

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The Cover

Large accumulations of fuel caused by insect epidemics may result in intense burns. Our lead story tells what one National Forest is doing to reduce this fuel buildup.

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Developing A Long-Range Fuel Program

John Maupin

In the last decade, a mountain pine beetle epidemic has destroyed as much as 90 percent of the lodgepole pine on 500,000 acres of the Targhee National Forest in southeastern Idaho. Of some 3 billion board feet of merchantable lodgepole, approximately 2 billion board feet are now deadwood.

During the next few years, these bug-killed trees will fall and convert the forest floor into a sea of jackstrawed timber (fig. 1). Downed woody fuel volumes may exceed 90 tons per acre. Douglas-fir and alpine fir regeneration will create a ladder effect between surface fuels and remaining overstory. As the forest canopy opens, solar insolation and surface windspeed will increase while relative humidity and fuel moisture will decrease. Fire rate of spread and resistance to control will be high for 40 to 60 years, until the tree canopy closes and the heavy fuel settles to the ground.

Figure 1.—Bug-killed lodgepole stands may contain up to 90 tons per acre of downed woody fuel.

Crisis Realized

In 1976, the Targhee management team realized that the Forest was facing a fuel crisis unprecedented in its history. The pine stands were nearing the peak of the 150- to 200-year lodgepole flammability cycle (fig. 2). Historically, at this point such bug-killed stands have been visited by large, stand-destructive crown fires such as the Sleeping Child Fire which swept through 28,000 acres of bug-killed lodgepole on the Bitterroot National Forest in 1961.

The management team concluded that unless an aggressive, long-term fuel management program was implemented, the alternative would be to contend with a large area of high hazard fuel for many years. An extensive recreation complex in the epidemic area consisting of resorts, campgrounds, and several hundred summer homes made the second alternative unacceptable.

Obstacles

Two obstacles impeded implementing a major fuel management program. The first was the absence of fuel management expertise at the Forest and District levels. A fuel management specialist was added at the Forest level and fuel management officers were added to the two most critical Ranger Districts. The second obstacle, an extensive lack of funds, was overcome when existing pro-

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Continued on next page

grams were adjusted to assist in accomplishing the fuel management task.

Potential Opportunities

Fortunately, at the time, the Forest had three potential fuel management opportunities. An extensive salvage program to harvest deadwood was just beginning and, spurred by the energy crisis, an explosion of free-use firewood cutters began visiting the Forest. Simultaneously, several manpower programs were being implemented which utilized labor-intensive projects.

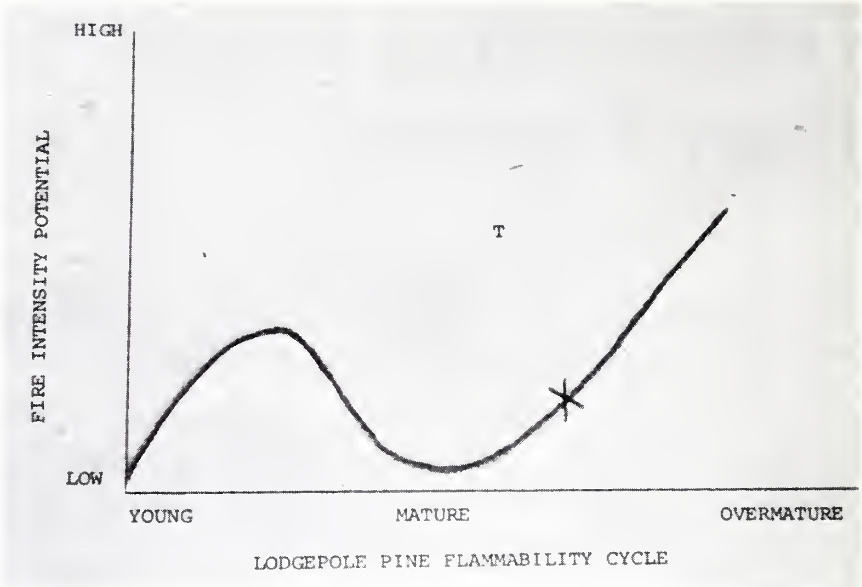

Figure 2.—Many lodgepole stands have fire flammability cycles. The *T* indicates the position of Targhee National Forest lodgepole stands in the flammability cycle.

Fuel Plan Developed

In 1977, a long-range fuel plan was developed for the Forest (fig. 3) with a goal of mitigating the hazard over a 5-year period. It combined a system of fuelbreaks with strategic area fuel reduction to break large expanses of high-hazard fuels into smaller blocks that are more easily handled under conflagration conditions. The first step of the plan involved hazard inventory and classification. Although most of the dead trees were still standing and hazard was consequently low, the inventory was made as if all trees were down.

During the second step, the Forest was divided into fuelbreak blocks similar to preattack blocks. Block boundaries were drawn along existing or proposed roads. Minimum fuelbreak widths, varying from 20 to 200 feet, were specified based on adjacent hazard classification and natural barriers. Meadows, clearcuts, and other barriers next to roads were considered when evaluating effective fuelbreak width.

After the Forest was divided into blocks, priorities were set for completion of fuelbreaks. The final step was to marshal resources available for the job.

Figure 3.—Slash piles are made by free-use firewood cutters along designated fuelbreaks.

Timber Sales

Forest guidelines were written to require timber sales to be placed near block boundaries so that roads were incorporated into the fuelbreak system. The guidelines also specified that timber sale fuel treatment plans consider the total fuel situation of the area.

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Firewood Cutters

Free-use firewood cutters provided the next fuel management opportunity. Prior to 1977, people were allowed to cut firewood by permit any place in the Forest. After extensive use of the media to inform the public of the problem, firewood cutters have been sent to cutting areas along roads designated as high priority for fuelbreak construction. There, they are allowed to fell dead lodgepole and are required to pile their slash (fig. 4). Only enough permittees are funneled into an area to insure adequate cleanup. Additional permittees are directed to other areas.

Public reaction to the firewood program has been excellent. Individuals have stated they were glad to help the Forest while harvesting a product useful to them. In 1978, over 12,000 permittees removed an estimated 40 million board feet of deadwood and created 900 acres of fuelbreaks. This program also improved roadside aesthetics. Initial attack success along high-risk roads increased too.

Manpower Programs Available

Manpower crews from the Young Adult Conservation Corps, Youth Conservation Corps, and Comprehensive Employment and Training Act, burn the slash piles from the firewood program. Five to eight person crews from the manpower programs are also used for fuelbreak construction along short sections of high priority fuelbreak or for hazard reduction work around high value improvements.

Suppression crews and prevention employees on the Targhee are involved in the fuels reduction program as time permits. As part of their regular duties, prevention people monitor the firewood program to insure fire requirements are followed. Snag felling and bucking is done by suppression crews in these areas for training and to maintain skill proficiency.

The Targhee National Forest still has a few years before the fuel situation becomes acute. We are hopeful that our long-range fuel program will enable us to ride out the notorious lodgepole flammability cycle without a catastrophic fire.

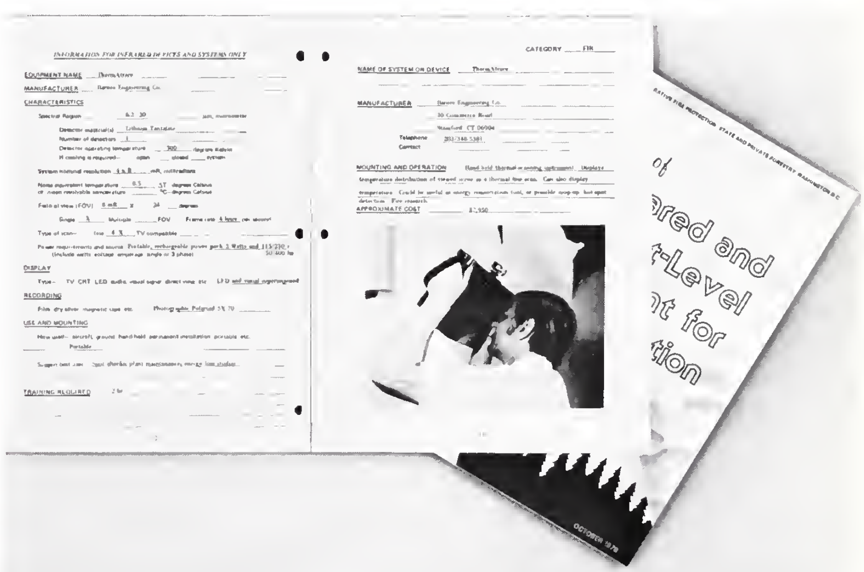
Looking For Infrared Fire Detection Equipment?

The Cooperative Fire Protection Staff Group in cooperation with the National Association of State Foresters recently released a comprehensive catalog of infrared and low-light-level equipment designed for use in fire protection programs.

The catalog, compiled by the San Dimas Equipment Development Center, reflects the current state-of-the-art in hand-held and airborne infrared devices.

There is equipment that can amplify weak night lighting into bright imagery and systems that provide displays of radiation based on thermal energy. This catalog gives the user pointers on how to select the proper device to fit a particular program as well as sources of supply and prices.

Free copies of "Catalog of Infrared and Low-Light-Level Equipment for Fire Protection" are available from U.S. Department of Agriculture, Forest Service Regional S&PF—Cooperative Fire Protection Staffs or from State Forestry organizations.



Slash Fuel Weights in Red Pine Plantations

Roswell K. Miller and Donald L. Schwandt

Many thousands of acres of coniferous plantations are capable of being intensively managed to produce increased volumes of wood fiber for industrial consumption. Red pine (*Pinus resinosa* Ait.) in the Northeastern and Lake States is one species which has been planted extensively. In the States of Michigan and Wisconsin alone, according to the most recent forest survey data available, over 900,000 acres contain stands of red pine, 85 percent of which are under 45 years of age.

Potential Fire Risks

Red pine is a species that responds well to intensive silvicultural manipulation and also has a high aesthetic appeal and value. Because of this, these stands may receive more than their "share" of nonconsumptive use by an expanding population seeking outdoor recreation experiences (Klukas and Duncan 1967). Silvicultural cutting, which increases fire hazards within these stands, combine with the elevated use rates by recreationists to increase fire risks.

Intensive silviculture, especially when applied in very productive plantations growing on land with a high site index, may require thinnings or other cuttings on the area every 5 or 10 years (Coffman 1976). It takes about 5 years for untreated slash produced by such cuttings to decompose enough to reduce the fire hazard to near pretreatment levels. During this period, these young stands are extremely vulnerable to fire. Frequent intermediate cuttings will maintain an artificially high fuel load throughout the rotation. This added hazard may pose a greater threat to these plantations than is warranted by the increase in monetary returns expected from an optimum schedule of silvicultural treatments. If this is the case and extra patrolling or some form of slash treatment is not possible, some modification of the treatment schedule may be the appropriate management to assure the survival of the stand.

Estimating Slash Weights

The total weight of available fuel is an indicator of the potential fire hazard that exists in intensively managed stands. To simplify estimates of slash produced by silvicultural treatments, such as thinnings within red pine plantations, slash weights were estimated from before- and after-treatment records on 44 plots thinned to various levels from various pretreatment basal area levels. The slash weights were estimated using the average stand diameter breast high prior to thinning and the tree-crown weight factors for red pine derived by Roussopoulos and Johnson (1975). Green slash weights were then converted to dry slash weights and regression analysis was used to correlate the slash weights produced with pre- and post-thinning levels of basal area per acre.

Results

The results of this analysis are listed in Table 1, which shows the total per acre weight of dry slash produced by thinning red pine, based on the original basal area per acre within the stand and the reduction in basal area achieved as a percentage of the original basal area. If the reduction in basal area is planned in a thinning not yet accomplished, an estimate of the slash weight likely to be produced can also be obtained from the table. The coefficient of determination indicates that 72 percent of the variation of the dry slash weight is explained by the table and the standard error of the estimate is ±1.6 tons.

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Table 1.—*Dry weight of slash produced by pulpwood thinning (to 3″ top d.i.b.)* in red pine plantations

Planned or actual reduction in basal area per acre.	Original basal area per acre of plantation					
	100	120	140	160	180	200
	tons/acre					
20%	1.7	2.5	3.4	4.3	5.3	6.2
30%	2.8	3.7	4.7	5.6	6.5	7.4
40%	4.0	5.0	5.9	6.8	7.7	8.6
50%	5.3	6.2	7.1	8.0	8.9	9.9
60%		7.4	8.3	9.2	10.2	11.1
70%			8.6	10.5	11.4	12.3

Use of the table by personnel doing or planning thinnings in red pine plantations is quite easy. Basal area is readily estimated in most plantations by using either the point sampling (prism) methods and/or the direct fixed area sample method. Applying thinning guidelines to original or residual basal areas easily allows determination of the percent reduction accomplished or planned.

All of the slash produced by any partial cutting operation, row thinning, or selection thinning will, of course, be available fuel for any fire that may occur within the stand. Availability of this fuel depends somewhat upon the time that has expired since the thinning was accomplished, the season of the year, or the dryness of the season.

Use of the table will at least call attention to a potential fuel hazard that may require corrective action, attention to more intensive prevention efforts, or attention to increased initial attack capabilities in the area.

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Forest Service And Fire Administration Team Up On Rural Fire Problem Analysis

R. Michael Bowman

The U.S. Department of Agriculture Forest Service and the U.S. Fire Administration have contracted with the Research Triangle Institute, Research Triangle Park, N.C., to analyze the fire problem in rural communities of less than 10,000 population. The contract has three phases:

Phase 1. Compile a bibliography of all rural fire literature. This bibliography will be used as a basis for establishing a rural fire file in the Forest Service's computerized fire information system called FIREBASE. The FIREBASE system currently provides users with bibliographic citations and abstracts of wildland fire information.

Phase 2. Compile data through statistical sampling and define the national fire problem in communities of less than 10,000 population. This phase will provide the analytical basis for planning and developing national and State programs to deal with the rural fire problem.

Phase 3. Develop a field-oriented system to evalute the effectiveness of Federal and State programs in solving the problems defined in phase 2.

For the first time, the Research Triangle Institute study will give fire managers a well defined analysis of the rural fire problem on which to base a coordinate action program. The Research Triangle Institute will complete the study late in 1979, and the data will be used to restructure the Rural Fire Prevention and Control program currently administered by the Forest Service.

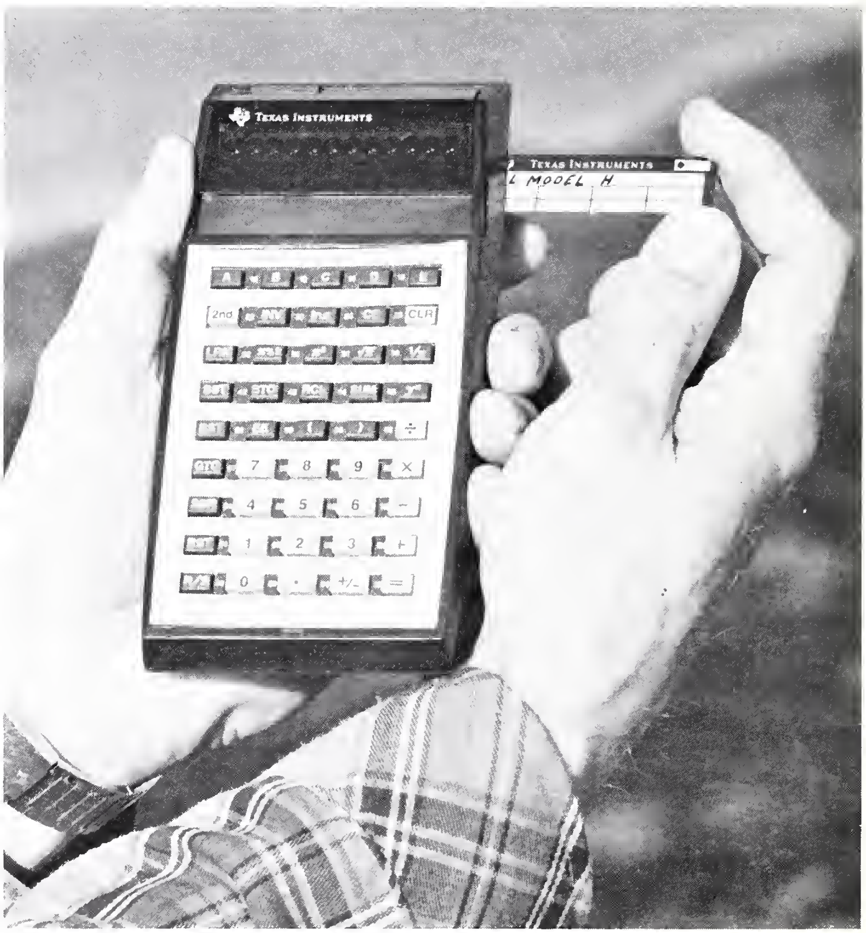
Mr. Bowman is assistant director, U.S. Department of Agriculture, Forest Service, Northern Region, Missoula, Mont.

Hand-Held Calculator For Fire Danger/Fire Behavior

Jack D. Cohen and Robert E. Burgan

A custom read-only-memory (CROM) designed specifically for fire danger/fire behavior calculations is under development. The CROM will fit in the back of the fully portable, hand-held Texas Instruments TI-59 calculator. This will enable machine calculation of National Fire Danger Rating Systems (NFDRS) (Deeming et al. 1977) and fire behavior values that formerly required nomograms and tables. Specifically, the TI-59 (with the CROM) will replace the manual NFDRS (Burgan et al. 1977) and many of the manual procedures (i.e., nomograms) taught in the National Fire Behavior Officer course (S-590). To aid the user, plastic keyboard overlays—one for fire danger and one for fire behavior—will identify the calculator keys by their corresponding input variables.

The CROM, in quantities ordered by individual agencies, should be available by midsummer 1979. Before it is distributed, training is planned for agency coordinators in the operating procedures and interpretation of outputs. The coordinators will in turn be prepared to train their users when they distribute the CROM and the users manual. Any TI-59 is appropriate. The TI-58 also uses a CROM, but is inappropriate because it lacks sufficient storage space and the necessary magnetic card reader.



Jack Cohen and Robert Burgan are research foresters with the U.S. Department of Agriculture, Forest Service, Northern Forest Fire Laboratory, Missoula, Mont.

NFDR Portion

All the required inputs are the same as in other systems except that the TI-59 version requires the number of days since greenup instead of the greenup date as in AFFIRMS (Helfman et al. 1975) and FIRDAT. For the fuels input, the user selects from the 20 NFDRS stylized fuel models. These fuel models are on magnetic cards and will need to be read into the TI-59 at the time of processing.

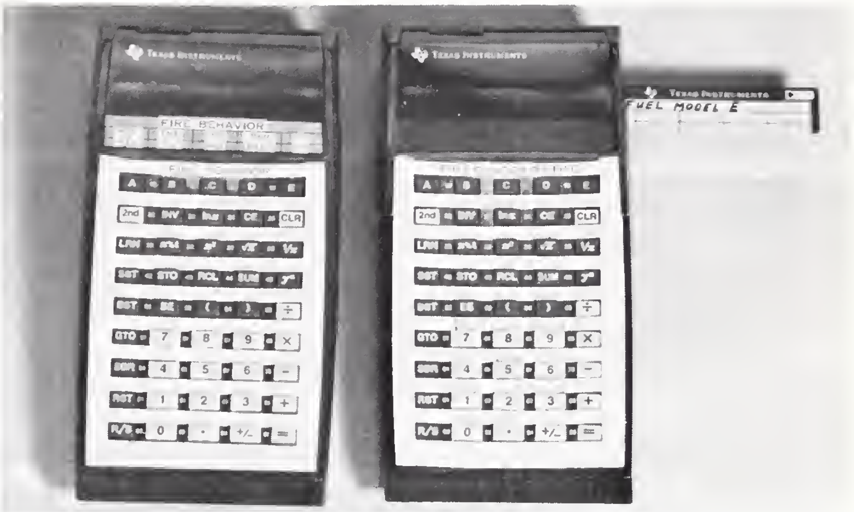
The calculator does not have the capability to store data from one day to the next. Therefore, the 10-day NFDRS form D9b must be used to record daily input and output data. To aid the operator, the calculator follows form D9b, flashing the column number for the next value to be recorded.

The TI-59/CROM will decrease the time necessary for non-AFFIRMS users to calculate NFDR components and indexes. By eliminating the graphical procedures, precision also will increase. The output will better correspond to AFFIRMS and FIRDAT outputs because the simplifications necessary for the manual NFDRS procedures are not necessary for the TI-59 procedures. Also, the TI-59 can substitute for the special off-station, off-hour (SPC) uses in AFFIRMS.

Fire Behavior Portion

The TI-59 fire behavior calculations required the following inputs:

- Cloud and canopy cover (fuel exposure to the sun)
- Dry bulb temperature (±°F)
- Relative humidity (%)
- 1-hour timelag fuel moisture (%)
- 10-hour timelag fuel moisture (%) (optional)
- 100-hour timelag fuel moisture (%) (optional)
- Live fuel moisture (%)
- Midflame wind speed (miles/hour)
- Percent slope
- Projection time (hours)
- Map scale (inches/mile)



to obtain the following outputs:

- Rate of spread (chains/hr)
- Heat per unit area (BTU/ft^2)
- Flame length (feet)
- Fire line intensity (BTU/ft^2/sec)
- Spread distance (chains)
- Map distance (inches)
- Perimeter of fire (chains)
- Area of fire (acres)
- Ignition probability
- Reaction intensity (BTU/ft^2/min).

The fine fuel moisture adjustment (for slope, aspect, time of day, and time of year), midflame windspeed adjustments, and spotting distance calculations continue to be made manually using the FBO field reference.

The fuels input uses the 13 fire behavior (NFFL) fuel models. These fuel models are in the CROM, so no magnetic card input is necessary. Any supplement or changes to the NFFL fuel models will require input using magnetic cards.

Increased Efficiency

The TI-59 procedure for calculating fire behavior estimates saves time and increases precision over the graphical methods. Because of high portability, procedural convenience, and time savings of the TI-59/CROM, the user will be able to make more fire behavior estimates in fire camp and on fire reconnaissance. The TI-59 allows simultaneous use of two fuel models to better describe heterogenous fuels by decreasing the time needed to calculate the combined rate of spread for the two fuel models. The simpler more convenient procedure of the TI-59 also facilitates on-site quantitative fire analysis for such activities as prescribed burning, management fires, and escaped fire analysis.

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The Bass River Fire: Weather Conditions Associated with A Fatal Fire

E. A. Brotak

Although wildland fires are fairly common in New Jersey, fatalities directly caused by fire are very rare. However, on July 22, 1977, a fire in the Bass River State Forest claimed the lives of four volunteer firefighters. Since these men were well trained and experienced, it is likely the fire exhibited unusual behavior, thus trapping them. This article evaluates possible causes of the unusual fire behavior.

Setting

Traditionally, the Pine Barrens in southern New Jersey are noted for major wildland fires during times of drought. The unusual combination of fuel, soil, and adverse weather conditions produces rapidly spreading surface and crown fires. Spread rates of these fires are among the greatest in the country.

Drought Conditions Present

Drought conditions were present in southern New Jersey all through the first half of 1977. At the Atlantic City National Weather Service, which is representative of the Pine Barrens, moisture for the 6-month period was 41 percent below normal. By July, New Jersey had experienced one of its worst spring fire seasons, with nearly 32,000 acres burned.

Dr. Brotak is an Assistant Professor of Meteorology at Kean College of New Jersey, Union, N.J.

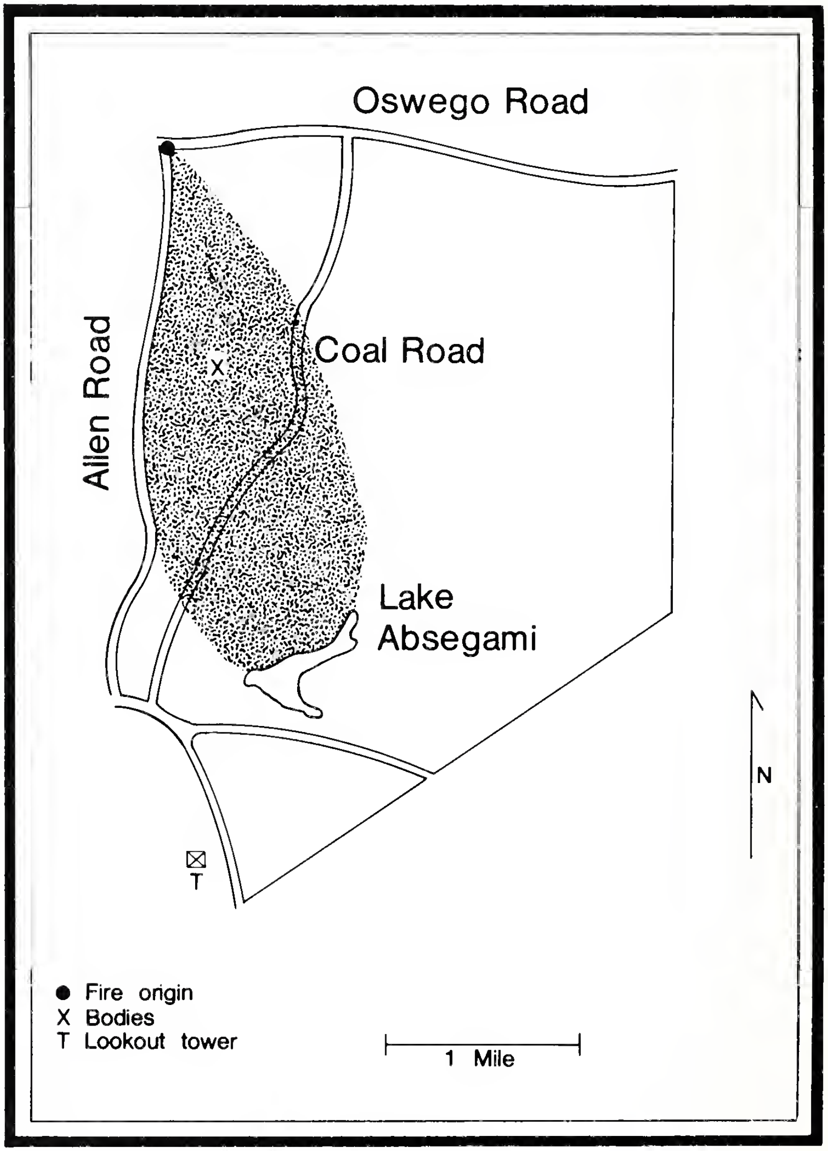

Figure 1.—Map of the Bass River

Summer normally brings green foliage and frequent rains, thus ending the fire season. However, this year, after some rain in June, drought conditions returned in July. A prolonged heat wave occurred from July 13 to July 21, with temperatures above 90°F on every day at many locations. On July 21, readings above 100°F were reported at some locations. This produced tinder dry fuels.

Fire Starts

The Bass River Fire started at approximately 1500 hours EDT on July 22 near the intersection of Allen and Oswego Roads (● on fig. 1). The exact cause of the fire has not been determined, but arson is suspected. A thick column of black smoke, indicating rapid burning, was spotted at 1501 EDT by the fire tower several miles to the south (T on fig. 1).

Suppression Action

An initial attack group was dispatched to the scene. Additional fire equipment was sent at 1525 EDT, so that by 1540 EDT there were nine fire units working the fire. At 1546 EDT, when it was apparent that the initial attack had failed, all units were ordered out of the fire area.

At 1600 EDT, a call was sent out to neighboring volunteer fire companies. They were told to report to the area and await instructions.

The Fatalities

A brush truck from the Eagleswood Fire Company with four men aboard responded to the call for help. It is not clear why, but this unit mistakenly proceeded into the fire area. At 1800 EDT, a reconnaissance helicopter spotted the charred truck on a narrow, dirt road between Allen and Coal Roads (X on fig. 1). At 1815 EDT, a search team located the bodies of the four men. Since more accurate information could not be obtained, the only estimate was that the men were trapped sometime between 1600 and 1800 EDT.

Fire Controlled

The fire itself was not officially controlled until 1500 EDT the next day. A total of 2,300 acres were burned. Most of this occurred in the 3-hour period from 1500 to 1800 EDT on July 22.

Weather Analysis

Early on the morning of the July 22, a dry cold front pushed across the fire area. By the time of the fire, the Bass River Forest was in the region behind the cold front (fig. 2).

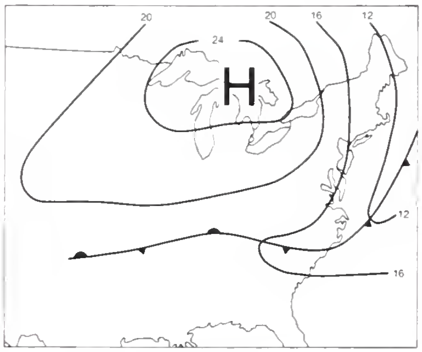

Figure 2.—1400 EDT Surface Weather Map

This area is noted for major fires in New Jersey (Brotak 1977). An examination of the 500 milibar map (fig. 3) showed New Jersey to be in the southeastern portion of a fairly well developed short wave trough. Again, this is a region noted for strong winds and major fires (Brotak 1977). Surface weather observations in the area (table 1) indicated warm temperature, decreasing humidity, and moderate winds from the north to northwest during the morning.

Fire Behavior

An investigation at the site where the men were trapped indicated two major points. First, from the direction of fire spread, it appears that the wind shifted from the northeast during a part of the fire's run. This is believed to be responsible for trapping the men.

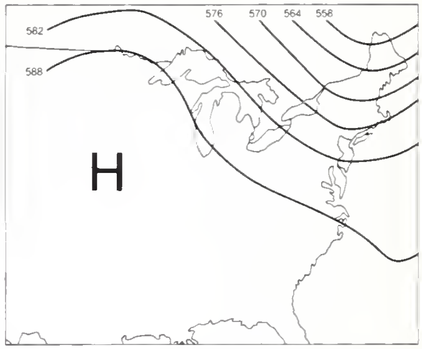

Figure 3.—0800 EDT 500 milibar Map

The second point noted was that fire intensity was much greater along this road than in the surrounding burned woods. This would indicate fire storm conditions that made it impossible for the men to survive.

Convective Column

The idea of a classic fire blowup is supported by observations of the fire and its convective column. The spotter in the Bass River fire tower noted flames reaching above canopy height which indicates flame heights of perhaps 40 or 50 feet. An observer a few miles away, noted a prominent convective column over the Bass River Fire. It was described as being "capped by a white, billowy cloud"; a classic cumulus top indicating extreme convection. Although there were other fires in the area, the observer noted that only this fire had a cumulus top. The convective column had maximum development occurring between 1500 and 1800 EDT, the time of blow-up at the surface. The convective column was also picked up on the Atlantic City radar scope, indicating a height of at least several thousand feet.

Atmospheric Instability

One of the prime ingredients for a blow-up fire is inherent instability in the atmosphere. The morning sounding at New York City (fig. 4) showed this inherent instability from

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the surface to about 2000 meters. The evening sounding (fig. 5), which is probably more representative of the conditions during the blow-up, showed extreme instability with a nearly dry adiabatic lapse rate from the surface to 2000 meters. High surface temperatures (table 1) added to the instability. This type of instability probably allowed the convective column over the fire to develop rapidly producing the blow-up at the surface.

Winds

An examination of the evening wind profile at New York City (fig. 6) showed moderate sustained surface wind; certainly strong enough to cause fire control problems. It also indicated constant wind speeds with height to an elevation of 2000 meters. According to Byram (1954), this would allow the convective column to develop more fully, producing blow-up conditions at the surface.

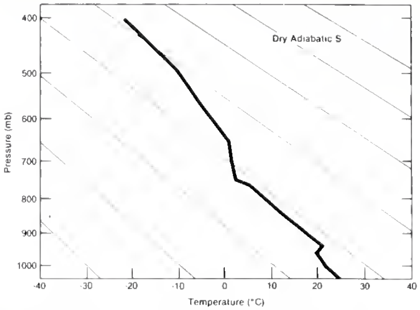

Figure 4.—0700 EDT New York City Temperature Sounding

Time (EDT)	Pressure (milibar)	Temperature (°F)	Dew-point (°F)	Wind Direction (°)	Wind Speed (knots)	Remarks
0155	094	78	66	330	09	
0252	098	77	66	330	09	
0353	102	76	66	330	09	
0451	105	75	66	340	10	
0553	112	74	67	350	08	
0651	120	75	66	350	10	
0755	128	76	65	010	11	
0850	136	80	64	010	12	
0951	142	82	58	010	12	Gusts to 20
1050	146	85	53	010	11	Gusts to 18
1156	146	86	52	020	12	
1254	146	86	55	010	10	
1355	146	86	51	330	12	Gusts to 19
1450	142	87	49	340	12	Gusts to 19
1551	140	87	46	350	14	Gusts to 24, smoke layer NE
1655	146	85	47	330	15	Gusts to 21, smoke layer NE-E
1755	146	83	45	340	14	Gusts to 20, smoke layer NE-E
1857	154	80	46	330	12	Smoke layer NE-E
1955	162	77	47	340	10	Smoke layer NE-SE
2057	173	70	47	330	06	
2156	183	70	48	330	08	
2255	187	69	48	340	08	
2355	193	67	45	340	08	

Peak wind at 24 knots from the North at 1548 EDT.
Fastest observed 1-minute wind speed: 17 mph from 330° at 1655 EDT.

Table 1.—Hourly observations at Atlantic City National Weather Service Office

The cause of the wind shift from northwest to northeast was also investigated. A sea breeze was ruled out since conditions were not favorable and such a sea breeze was not observed at Atlantic City. The surface map showed no indications other than the fact that winds are known to be variable behind a cold front. It is possible the fire itself induced such a flow through indrafts. However, another possibility exists that was indicated by the hourly observations at Atlantic City (table 1). The pressure, which had been rising steadily after the frontal passage, fell (from 1400 to 1600 EDT); then began rising again. The temperature climbed steadily throughout the day despite the passage of the cold front, and after 1600 EDT, began to drop off sharply. During the period from 1600 to 1800 EDT, the wind direction went from northwest to north at Atlantic City with increasing speeds and gustiness. The peak gust for the day was from the north at 24 knots and occurred at 1548 EDT.

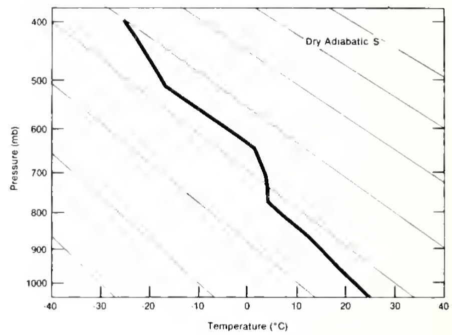

Figure 5.—1900 EDT New York City Temperature Sounding

Pressure Trough

It is possible that the fire was affected by a surface pressure trough. Such a trough would cause the noted pressure falls and changes in wind speed and direction. The occurrence of a surface pressure trough behind a cold front, with the colder air behind it, is not uncommon in the east. Such a trough could easily be overlooked in the synoptic-scale observation

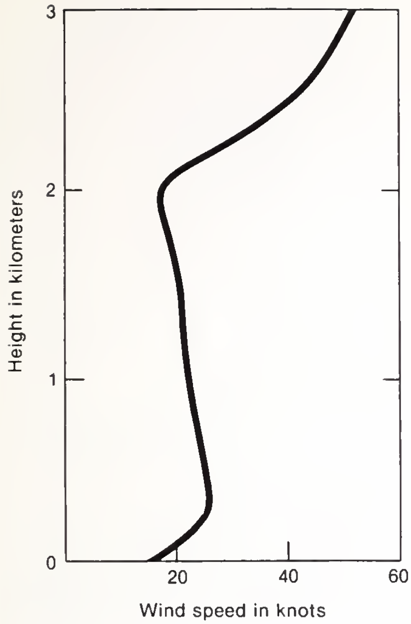

Figure 6.—1900 EDT New York City Wind Profile

network of the National Weather Service. The relationship of major fires and surface troughs has also been noted before in the east (Brotak 1977).

Summary

In order to avert such tragedies in the future, the possible causes of blow-ups must be determined and understood. Obviously, very heavy fuel loads and tinder dry conditions are contributing factors. Topographic effects, in this case, have been ruled out, since there was only a very slight slope to this basically flat land. Where the terrain is steeper this could have a major impact. Weather conditions play a key role and are extremely complex. Fire managers must know and understand local patterns and variance to maximize the efficiency and safety of the suppression job.

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